WAVEWARE™

WIRELESS COMMUNICATION SYSTEMS

Paging System Handbook

Version 7.XX Firmware

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Warranty: WaveWare Technologies, Inc. warrants this equipment to operate properly for a period of one year from date of shipment from WaveWare Technologies, Inc. offices, including parts and WaveWare factory labor, but not including shipping. The warranty becomes void if the equipment is physically damaged by external events.

Disclaimer: This equipment has not been designed to operate as a primary means of life/safety communications, and should only be used as a secondary means of communications. The nature of radio paging is such that alert messages are not guaranteed to be delivered to pagers, due to a variety of causes, some of which are out of the control of the equipment manufacturer and the user of the equipment. The WaveWare paging equipment uses a one-way radio paging protocol called POCSAG, which relies upon proper operating frequency coordination and licensing, proper external environmental conditions, and proper equipment maintenance, in order to deliver messages to pagers in a reasonably reliable manner. WaveWare Technologies, Inc. is not liable for damages caused by failure of delivery of messages from WaveWare equipment to pagers, beyond the normal warranted equipment repair or replacement during the warranty period.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. Changes or modifications to the equipment not expressly approved by WaveWare Technologies, Inc. could void the user's authority to operate the equipment.

Site Licensing: This equipment requires a site license from the FCC in order to be operated. The site licensing can be obtained through several means, including Shared-Use Site Licensing from WaveWare, FCC Site Licensing through WaveWare, directly from FCC licensed Frequency Coordination agencies, or from anyone that can help you fill out the proper FCC forms payment submittal requirements.

Introduction

Your **WaveWare**$_{tm}$ **Paging System** allows you to send paging messages to one or more persons via pagers, and devices that incorporate POCSAG paging data receivers. You can setup automatic transmission of messages or you can compose messages on the fly and transmit them immediately. The WaveWare Paging Encoder can be provided in either standalone form or bundled with a radio transceiver to become a paging system.

When you attach your paging system to a PC or other Host Device, plug in the provided power adapter, and install and activate your paging software, you will be ready to make full use of the paging system. The **WaveWare Paging System** can have a pager database programmed using the WaveWare Paging Encoder Setup Software, or you can immediately use the **WaveWare Paging System** without programming.

Your **WaveWare Paging System**, using V7.XX firmware, has the following capabilities:

- Serial port controlled operation via RS-232 serial port, with DIP switch configurable communication parameters. Baud rates of 300, 1200, 2400, and 9600, with None, Even, and Odd parities. Default setting is 9600 N81, unless specified differently by customer requirements.
- 2 Watts effective radiated power with approximately 1 mile range, depending upon terrain and obstructions. 5 Watt model also available.
- UHF band (450-470 MHz) synthesized frequency transceiver. See the label on the back of the paging system to identify the operating frequency of the paging system. Default is 467.800 MHz.
- Industry standard POCSAG paging protocol covering the full range of paging functions, including:
  - 512, 1200 and 2400 bps RF data rates, auto-switching
  - tone/vibe only, numeric and alphanumeric paging message formats
  - multiple tone/vibration patterns
  - batch message delivery, with up to 240 characters per message (500 characters in WaveWare mode)
- Support for multiple paging control protocols, including:
  - TAP v1.8 (variations also known as IXO and PET)
  - Extended TAP (TAP compatible extended interface supporting embedded control characters and paging message encoding parameters appended to the pager ID)
  - Simplex TAP, a single serial command string composed of a standard TAP message block. **NOTE:** Simplex TAP is the recommended interface protocol for system developers.
  - COMP1, delivery of <CR> or <CR><LF> delimited data to one or more pagers
  - COMP2, a command string composed of PagerID<CR>Message<CR>
  - WaveWare, a proprietary single serial command string that includes capcode, function code, RF data rate, and message values. WaveWare protocol can be used as either simplex or duplex operation.
- Programmable Carrier Detect mode, which allows the automatic delay of transmission while a nearby transmitter of the same frequency is operating. Default is Carrier Detect On.
- Programmable on-board pager database, supporting approximately 50,000 pagers, and up to 10 groups of 20 pager IDs each, stored in non-volatile EEPROM memory. The pager database is not required for WaveWare protocol, Extended TAP protocol, or Pager ID as Capcode mode. Windows 32 bit software, called WaveWare Paging Encoder Setup is provided for pager database programming, range testing, and general messaging.
- Onboard watchdog timer to keep the paging system on-line at all times
- Hardware or Software Flow Control, DIP switch selectable. Default is Hardware Flow Control.
- Verbose or Non-Verbose Modes, DIP switch selectable. Default is Verbose TAP. Verbose output means the paging system responses include more information than non-verbose responses.
- Programmable transmitter duty cycle management, in percentage, from 0 to 100. Default is 50% Duty Cycle. A 0 value also means 100%.

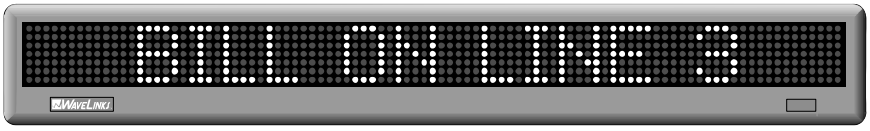
- Remote administration of Pager Database. Pager database can be modified using specially formatted TAP paging messages.
- Programmable Timed Messaging function, allowing the paging system to monitor the host system, and automatically deliver alert paging messages if the host system does not communicate to the paging system within a one minute time cycle. The Timer Triggered Messaging function can be enabled or disabled via programming, and can be used as a repetitive RF ping for fully supervised applications. Predefined alert messages can be up to 60 characters in length.
- Programmable Alarm Monitoring function, causing delivery of alert paging messages upon a Contact Close or Contact Open event, or both events. Contact monitoring input is a wet voltage input, ranging from 5 to 24V, wired into an RJ-45 jack on the paging system. Predefined alert messages can be up to 60 characters in length.
- Programmable maximum batch size for batch messaging, ranging from 1 to 32 messages per batch. Batch messaging allows higher message throughput by outputting a single POCSAG preamble for the batch of messages. Default maximum batch size is 10 messages per batch.
- Programmable Pager ID as Capcode mode. This mode allows a pager ID value in the COMP2 or TAP protocols to be treated as a capcode, allowing a bypass of the pager database, and allowing direct encoding of the pager ID value as the pager capcode. This method reduces database configuration efforts and opens the paging encoder up to use of the full approximately 2 million POCSAG capcode values. NOTE: When Pager ID as Capcode mode is active, all paging messages are output at 512 bps RF data rate.
- Programmable Carrier Detect Polarity, supports integration of the WaveWare paging encoder to a variety of radio transmitters.
- Programmable Data Encoding Polarity, supports use of Normal or Inverted polarity on the encoding of messages.
- Programmable busy terminal flow control signaling, using either serial port response code flow control or CTS/XOFF (hardware/software) flow control. The default is serial port response code flow control. If serial port response code flow control mode is disabled, DIP 1 of the DIP switch bank toggles between hardware and software flow control.

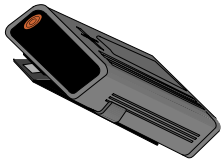
Obtaining Pagers for Your Paging System

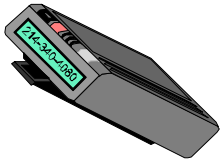
You can use a wide variety of paging receiver types with **WaveWare Paging System**s, including tone/vibe, numeric, alphanumeric, and wireless message centers.

You can obtain WaveWare compatible paging receivers from many sources, including Motorola, NEC, Panasonic, and others. The paging receivers that you obtain for use with the **WaveWare Paging System**s should meet the following basic specifications:

- **Frequency** - All paging receivers used with the **WaveWare Paging System** must be of the same frequency and must match the frequency of the paging system transmitter. See the label on the WaveWare Transmitter Unit to identify the operating frequency of your paging system.
- **POCSAG** - All paging receivers used with the **WaveWare Paging System** must be POCSAG compatible. POCSAG is the paging protocol most frequently used in the paging industry.
- **Pager Type** - You can mix different paging receiver types in a WaveWare installation. You can obtain the following paging receiver types for use with the **WaveWare Paging System**:
  - Tone/vibe only, with or without multiple tone/vibrate cadence features. **WaveWare Paging System**s support pagers with multiple tone/vibrate features. WaveWare Tone/Vibe Pagers have two capcodes and have multiple tone/vibrate features.
  - Numeric
  - Alphanumeric
  - WaveWare Wireless Message Centers (allow group message notification on scrolling multicolor LED displays, using **WaveWare Paging System**s to communicate to the message centers)
- **Paging Data Rate** - You can mix different paging data rates (baud rates) in a WaveWare installation. The data rate of the paging receivers can be your choice of 512, 1200, or 2400 bps (bits per second).
- **Capcodes** - Each paging receiver used in a **WaveWare Paging System** installation must have one or more capcodes (addresses) programmed into it. Each paging receiver used with a particular WaveWare installation, regardless of paging receiver type, must have a unique capcode programmed into it, in order to be able to transmit messages to that individual paging receiver. Contact your paging systems dealer for capcode assignment information.







Paging System Operation

Your **WaveWare Paging System** includes a UHF transceiver, and onboard RS-232 communications, that transmits paging messages using the industry standard POCSAG paging protocol. The RS-232 communications allow you to interface the paging system to a PC or to other devices and systems that use RS-232 serial communications (Host Devices). Other models of **WaveWare Paging System** products include encoder only models, and the combination of the paging encoder with VHF and UHF radio transceivers.

The types of paging receivers that are compatible with your **WaveWare Paging System** include:

- Any POCSAG compatible paging receiver operating on the same frequency as the paging transmitter (in the UHF band) and operating at 512, 1200, or 2400 bps data rate. Pagers of this type include tone/vibe, numeric, and alphanumeric models.
- WaveWare Wireless Message Centers, operating at the same frequency as your paging system. WaveWare Wireless Message Centers are normally configured to receive at a 512 bps data rate.

The paging system may be controlled by a PC, or other control system, that is running software designed to interface to the paging system. WaveWare wireless communication systems software is designed to take full advantage of the features of your **WaveWare Paging System**. The TAP, WaveWare, COMP1, and COMP2 interface protocols are defined in this handbook to allow you or others to develop software or devices to directly control the transmitter.

The paging system maintains an input buffer, which can continuously receive commands from the Host Device while paging messages are being transmitted. When a command is received from the Host Device, the paging system responds with a message back to the Host Device. The paging system encodes the paging messages into POCSAG paging format and transmits the encoded paging message to the paging receivers of your choice.

PC software developed to utilize the **WaveWare Paging System** can be designed to maintain a simple database of pager ID numbers, or the software can be designed to allow definition of paging receiver attributes, including:

- Pager Type
  - Tone/Vibe Only, with or without multiple tone/vibrate cadences
  - Numeric
  - Alphanumeric
- Capcode - The unique address assigned to each paging receiver
- RF Data Rate
  - 512 bps
  - 1200 bps
  - 2400 bps
- Function Code – One of four values that pagers can use to change how the behave when receiving a new message

The Transmitter Unit may require the setting of an onboard DIP switch to change communication interface parameters. Refer to Appendix B – DIP Switch Settings for details on how to configure the DIP switches, as required.

If you want to use the TAP interface protocol with 1 to 4 digit pager IDs, you will need to configure a pager database, using the WaveWare Paging Encoder Setup software. You can obtain the WaveWare Paging Encoder Setup software either from the WaveWare Product Support CD or from the WaveWare web site, at:

http://www.wirelessmessaging.com/media/encodersetupv7/WWEncoderSetupV7.exe

Paging System Installation

Your **WaveWare Paging System** includes an encoder/transmitter unit, a "Rubber Duck" Antenna, a serial interface cable, and an AC/DC power adapter. Refer to the diagram on the following page. To install the paging system, perform the following steps:

1. Attach the "Rubber Duck" Antenna to the Transmitter Unit. In normal paging operations, the paging transmitter antenna should be oriented in a vertical position to maximize the paging range.

Note: Do not attempt to operate the paging system without the antenna connected to the paging transmitter, as damage to the paging transmitter may occur.

2. Mount the Transmitter Unit as required to a wall surface, using the mounting slots. You need to remove the front cover to install the anchor screw..
3. Plug the AC/DC power adapter into the power connector, and connect the DB9 serial cable between the paging system and the serial port connector on the back of a Host Device, such as a PC or an alphanumeric paging terminal. If the serial port has a DB25 connector, you must provide a DB25 to DB9 adapter, which is available from computer supply companies. Tighten connector screws. Please note that you may require a null modem adapter and/or other wiring modifications to properly connect to host systems.
4. Plug the AC/DC Power Adapter into a 110 VAC power outlet. The red colored PWR/BAT LED indicator on the Transmitter Unit should be illuminated when power is properly applied.
5. Program the pager database, if required, using WaveWare Paging Encoder Setup software, which is available from the WaveWare web site or from the WaveWare Product Support CD
6. If you are using a PC as a Host Device, load paging control software, such as WaveWare software, on the PC and configure it to operate with your **WaveWare Paging System**. Make sure the proper serial port settings are defined. The green colored TX LED indicator on the Transmitter Unit should illuminate during a paging transmission. If the Carrier Detect function is enabled, you may see the green colored CD LED indicator temporarily illuminate prior to some paging transmissions, if a carrier signal is detected from a nearby transmitter at the same frequency as your **WaveWare Paging System**.

Trouble Shooting

POWER

When the WaveWare Paging Transmitter Unit is assembled and power is applied, you should be able to see a red Power indicator illuminated on the side of the Transmitter Unit. If not, verify that all connections are tight and verify that 110 VAC power is available at the power outlet. If connections are tight, power is available and the red Power indicator doesn't illuminate, determine if the Power Adapter is at fault by trying another Power Adapter. If the Transmitter Unit still does not respond, the Transmitter Unit is most likely in need of repair or replacement.

At power-up, the Transmitter Unit is supposed to send a status message through the serial port to the host PC.

PAGERS

When you send a paging message command to the Transmitter unit from the PC, the green RF TX indicator on the Transmitter Unit should illuminate for a few seconds to indicate that transmission is occurring. If you don't receive a message on the selected paging receiver, follow the checklist below to troubleshoot paging reception:

1. Pager turned on
2. Pager has fresh battery
3. Pager properly defined in the paging control application software on the host PC.
4. Pager located at least arms length away from Transmitter Unit during transmission. (Some paging receivers do not properly decode paging messages when the paging receivers are located in close proximity to the transmitter antenna. Holding a paging receiver at arms length away from a transmitter antenna is usually sufficient to allow the paging receiver to properly decode a paging transmission).
5. Antenna attached to Transmitter Unit
6. Pager at the same frequency as the Paging System
7. Pager uses POCSAG paging protocol

CARRIER DETECT

The Carrier Detection signal is indicated by the green RF CD indicator on the side of the Transmitter Unit. When a carrier signal is detected, and the Carrier Detect mode of operation is enabled, the paging system will delay transmission until the detected carrier signal disappears. If the Carrier Detect operating mode is enabled in the paging system, and you find that paging transmissions are delayed for significant periods of time due to interference on the channel, you should temporarily inactivate the Carrier Detect mode to allow transmissions to occur regardless of other transmissions on the channel. You may find that you get excellent paging reception even with Carrier Detect inactivated. You may want to contact your nearest FCC field office to find out what is causing the unwanted interference on your channel. Please note that the typical **WaveWare Paging System** installation uses a 2 watt system that operates subservient to other operators on the same frequency. If you find that the unwanted transmissions are legal, and if you find that your paging reception is suffering due to the unwanted transmissions from another source, you may have to change your paging system to another operating frequency. A frequency change is a costly process and should be avoided.

If you have multiple **WaveWare Paging System**s installed in the same facility, and at the same operating frequency, you should activate the Carrier Detect mode on all paging systems in order to ensure paging messages are being properly transmitted to paging receivers.

SITE SURVEY

Some installation sites might cause paging reception problems. It might be beneficial to perform a site survey by monitoring the radio waves in the area that you want to install a system. It also might be beneficial to perform a range test to find out of the installed signal will be strong enough to be received in all of the areas you want to cover. A site survey consists of both monitoring for radio signals on your channel, and verifying that the paging system has adequate power to cover the expected area.

Following are some rules of thumb to use in deciding whether or not to perform a site survey.

Perform a site survey if the facility or paging conditions meet one or more of the following criteria:

1. Hospital or medical facility
2. Unobstructed line of sight distance exceeding 1 1/2 miles
3. Building above 5 stories
4. Building greater than 50,000 square ft
5. Multi-building facility
6. Vicinity of seaports and shipyards
7. Pager reception problems occur
8. Excessive carrier signal detection conditions occur at the paging system

You can monitor for radio signals using a simple multi-channel UHF band scanner, from sources like Radio Shack. You listen to the scanner for any audio output on that channel. The louder the audio, the stronger the signal.

If the scanning results in excessive use of that radio channel, consider changing the paging system to operate on another radio channel. Use the scanner to identify the lowest traffic channels of those channels available to you. You may need to monitor for several minutes to determine which channels are busier than others.

If pager reception problems occur, and there is not excessive foreign traffic on that channel, then consider boosting the strength of the paging signal. Typically, when you boost a signal, you will need to change the paging system equipment and pagers to a channel that allows higher power transmissions, measured in watts.

Appendix A – TAP Interface Specifications

This appendix is included for those who want to develop their own paging control software or add an interface for the **WaveWare Paging System** to their existing software applications..

A simple definition of the TAP protocol is that the TAP protocol normally requires a connect and disconnect process and normally assumes that the Host system maintains a database of pager reference numbers called IDs, and that the paging system maintains a database of all paging parameters associated with each ID. The TAP interface supports paging messages up to 244 characters in length. The actual maximum length of transmitted messages in the WaveWare TAP interface is 245 minus the ID field length. With an ID value of 5, you can transmit up to 245 characters per message. With an ID value of 1233425120, you can transmit up to 235 characters per message.

To configure your **WaveWare Paging System** to use the TAP paging protocol, you may be required to configure the DIP switch bank in the paging encoder. Please refer to Appendix B – DIP Switch Settings, for details on configuring communication protocols. As a quick reference, a typical DIP switch setting for the TAP interface is all 8 switches in the ON position, which tells the system to operate in TAP interface mode, with communication parameters of 9600N81, hardware flow control, and verbose responses from the encoder.

Your **WaveWare Paging System** typically communicates with a PC or other host device via RS-232 at 9600 Baud, 8 data bits and 1 stop bit. The eighth data bit is ignored (no parity). You can configure the paging system for other serial communication parameters. Please refer to Appendix B – DIP Switch Settings, for details on serial communication parameters.

The paging encoder maintains an input buffer which can receive commands from the PC while a page is being transmitted. The input buffer should be able to contain approximately ten paging messages before getting full. When a command is received from the PC, the paging system responds with a message that includes error messages if the command was not understood or not properly transmitted. The first three digits of each paging system response conforms to the response codes defined in the TAP v1.8 specification. See Appendix D – TAP Response Codes for a listing of the response codes.

The paging encoder encodes paging messages into POCSAG paging format and transmits the encoded paging message. If the Carrier Detect function is enabled, transmissions will be delayed while interfering signals are detected.

Control characters recognized by the paging system in TAP protocol mode include:

CARRIAGE RETURN	<CR>	$0D
START OF TEXT	<STX>	$02
END OF TEXT	<ETX>	$03
END OF TRANSMISSION	<EOT>	$04
SUBSTITUTE	<SUB>	$1A
ESCAPE	<ESC>	$1B

Control characters generated by the **WaveWare Paging System** in TAP protocol mode include:

LINE FEED	<LF>	$0A
CARRIAGE RETURN	<CR>	$0D
ACKNOWLEDGE	<ACK>	$06
NEGATIVE ACKNOWLEDGE	<NAK>	$15
ABANDON TRANSACTION	<RS>	$1E
ESCAPE	<ESC>	$1B
END OF TRANSMISSION	<EOT>	$04
XON	<XON>	$13
XOFF	<XOFF>	$11

The TAP mode of operation can be supplemented with two additional functions, including Host Monitoring Function, and Contact Monitoring Function. See Appendix J - Host Monitoring Function and Appendix K - Contact Monitoring Function, for operational details.

The operational modes available for paging using the TAP Paging Protocol include:

- System Identification Command
- Paging Session Login
- Paging Operation
- Paging Session Logout

SYSTEM IDENTIFICATION COMMAND

The System Identification command allows installation programs and other software applications to poll serial ports for the existence of a WaveWare paging encoder using the standard ATI command. This can be used for a supervised process (also called keep-alive) where the host system periodically polls the paging system for a response. When the WaveWare paging transmitter recognizes a command formatted as **ATI<CR>**, the transmitter responds with the following message:

WaveWare Paging Encoder v7.28<CR>

The firmware version number is subject to change.

PAGING SESSION LOGIN

The Paging Session Login mode allows a Host Device, sometimes called a Remote Entry Device, to initiate communications with the paging system. With the **WaveWare Paging System**, the Login process is optional. The **WaveWare Paging System** will automatically login a Host Device and process the paging message if it recognizes a properly formatted TAP message block at any point in it's operation.

The Host Device initiates the Login process by transmitting a carriage return **<CR>** character every two seconds until the paging system properly responds or until the Host Device times out and notifies the operator of a bad connection. The paging system will respond with **"ID=<CR>"** (Note: the quotation characters are used here only for reference and are not included in the transactions). The "ID=<CR>" will not be repeated or timed out by the paging system.

The Host Device should respond to the paging system with:

<ESC>PG1<CR> or **<ESC>pg1<CR>**

The **WaveWare Paging System** will then respond with:

110 1.8<CR>WaveWare Paging Encoder v7.29<CR><ACK><CR>

The "110 1.8" message indicates that the system conforms to TAP specification version 1.8 and should be backward compatible with earlier TAP implementations. The paging system then notifies the Host Device that it is ready to accept messages as follows:

<ESC>[p<CR>

This completes the Login process.

PAGING OPERATION

Paging transactions are transmitted in blocks of characters, where one transaction is sent per block. Each block sent by the Host Device is acknowledged by the paging system. The Host Device must wait for this acknowledgement before sending the next block. The **WaveWare Paging System** provides acknowledgement in the form of an <ACK> character.

The **WaveWare Paging System** supports TAP message blocks up to 253 characters in length, with a 235 to 244 character message, from 1 to 10 characters for ID (pager number), plus 5 control characters, and a 3 character checksum. (Message field length is restricted as follows: when a 1 character ID is used, a 244 character message can be accommodated, and so on, for a total of 253 characters, such that when a 4 character ID is used, a 241 character message can be accommodated. The maximum ID field length of 10 causes a maximum message field length of 235 characters). A block always carries two fields with their associated carriage returns. The message field may be empty, but it's carriage return must be included in the data block. The TAP message block format is as follows:

<STX>ID<CR>Message<CR><ETX>Checksum<CR>

The ID field is a one to ten character pager number. Leading zeroes are not required. The Message field accommodates up to 235 alphanumeric characters. The Checksum field provides a checksum for the previous portion of the TAP message block. See Appendix D – TAP Checksum Calculation, for sample code to create the checksum field.

The Message field can be formatted as follows:

- For alphanumeric paging messages, all 7-bit ASCII "non-control" characters are valid except ^, ~, and _ (underscore)
- For numeric paging messages, valid characters are the numbers 0 through 9, - (hyphen), and space
- Control characters can be embedded into paging messages so that high end alpha pagers and paging data receivers can respond with formatted screen displays and with formatted serial output, as required. Control characters (typically <CR> and <LF>) can be embedded in messages by using the Transparency Option. The Transparency Option replaces a non-printable control character with the SUB (Hex 1A) character immediately followed by the control code offset by 40 Hex. See Appendix G - Embedded Control Characters for details on how to embed control characters in paging messages.

The WaveWare TAP interface supports ID field lengths from 1 to 10 digits. The ID field can be formatted using two different methods, as follows:

- Method 1 - ID field lengths from 1 to 4 digits will cause a pager database lookup. ID fields of this format must contain numeric digits only. The numeric ID value will be compared to the ID values stored in the **WaveWare Paging System**'s onboard pager database.
- Method 2 - ID field lengths from 5 to 10 digits will cause Extended ID processing. Extended ID processing assumes that the last 3 digits of the ID field define paging message encoding attributes, while the preceding digits define the pager capcode. Extended ID processing allows you to avoid the process of configuring a pager database in the **WaveWare Paging System**. See Appendix E – Extended ID Processing for details on how to format the ID field.

When the Host Device delivers a TAP Message Block to the **WaveWare Paging System**, if the message block is properly formatted, and a 1 to 4 digit ID field matches the pager database, the paging system will respond with an initial response code as follows:

211 Page(s) Sent Successfully<CR>

If your **WaveWare Paging System** is configured to operate using TAP Non-Verbose mode, the paging system will respond only with an initial response code of:

211<CR>

Following the first part of the TAP message block response, if the input buffer of the paging system has capacity for another TAP message block, the paging system will send the following message.

<ACK><CR>

The <ACK><CR> response can be used as a flow control method to prevent overflow and lost messages. As alternative flow control methods, you can use either hardware or software flow control. If the paging system DIP switch is set to hardware flow control mode, the RS-232 CTS signal will be deasserted when the input buffer doesn't have capacity for another TAP message block, and reasserted when capacity exists in the input buffer. If the DIP switch is set to software flow control mode, an XOFF character (0x11) will be output in the response string to indicate the the input buffer doesn't have capacity for another TAP message block. When capacity is available, an XON character (0x13) will be output.

When the Host Device delivers a TAP Message Block and a checksum error occurs, the paging system will respond with an error message and a <NAK><CR>, which tells the Host Device to resend the transaction. See Appendix E – TAP Response Codes for more information on paging system response messages. If the TAP Message Block checksum is OK, but the Message Block violates formatting rules, the paging system will respond with an error message and an <RS><CR>, which tells the Host Device to abandon the transaction. An example error message sequence follows:

514 Checksum Error – Exp. 2:9 Got 2:X<CR>

<NAK><CR>

PAGING SESSION LOGOUT

The Paging Session Logout mode allows a Host Device, sometimes called a Remote Entry Device, to stop communications with the paging system. With the **WaveWare Paging System**, the Logout process is optional. The **WaveWare Paging System** will automatically login a Host Device and process the paging message if it recognizes a properly formatted TAP message block at any point in it's operation.

To initiate a logout (disconnect sequence) the Host Device should send the following to the paging system:

<EOT><CR>

Upon recognizing a logout command, the paging system will respond with:

PAGING EXCHANGE DISCONNECT<CR><ESC><EOT><CR>

Appendix B – DIP Switch Settings

You may be required to configure the DIP switch bank in the paging encoder to establish the appropriate operating mode and serial communication parameters.

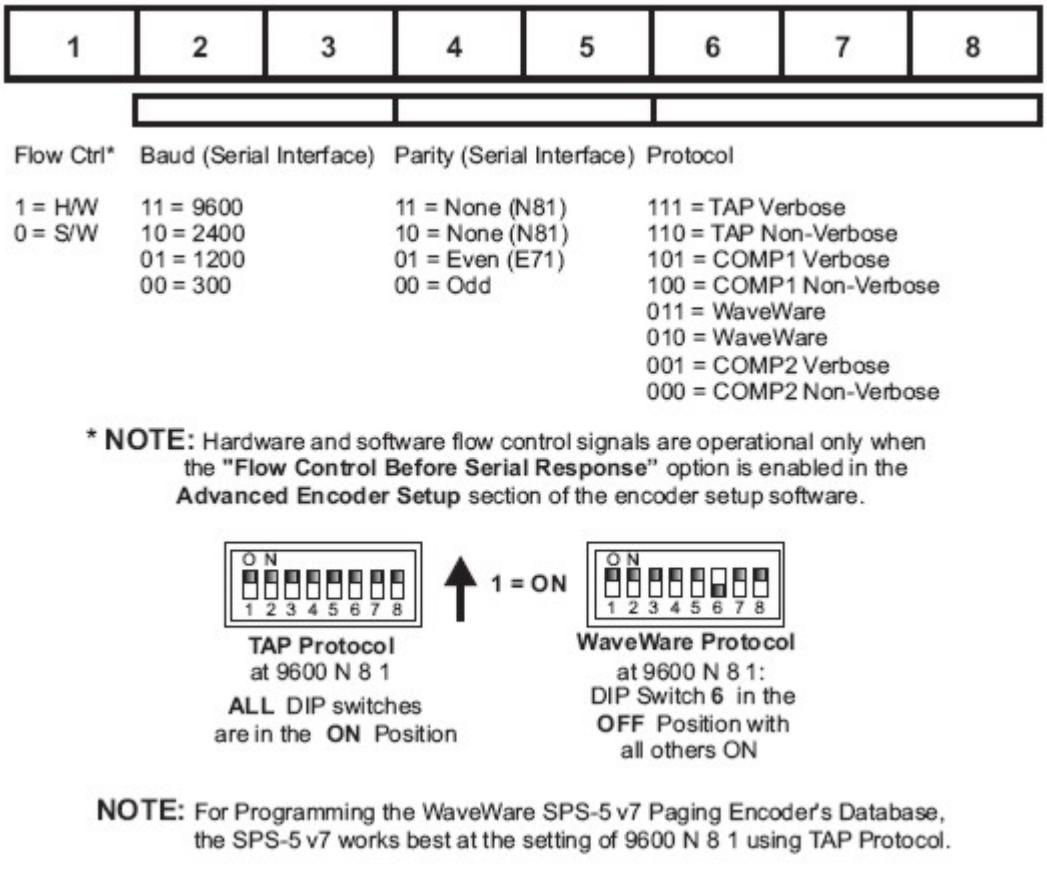
Your **WaveWare Paging System** typically communicates with a PC or other host system via RS-232 at 9600 Baud, 8 data bits and 1 stop bit. You can configure the paging system for other serial communication parameters.

The available operating modes include TAP Verbose, TAP Non-Verbose, COMP1, WaveWare, COMP2 Verbose, and COMP2 Non-Verbose.

COMP2 means that data formatted as PagerID/GroupID<CR>Message<CR> will cause the Message to be delivered to the specified PagerID or GroupID. TAP and COMP2 Verbose means that the paging system will include human readable messages after each paging request is received. TAP Non-Verbose reduces the paging system human readable response to 3 digit numeric codes. In the COMP2 Non-Verbose mode the response is reduced to none at all. The Non-Verbose modes are useful in situations where you want to minimize the serial data throughput requirements, which tend to allow paging messages to be delivered more quickly. Refer to Appendix A for a definition of the TAP protocol and Appendix I for a definition of the COMP2 Verbose and Non-Verbose protocol. COMP1 means that any data received on the serial port will be sent to all pagers in group one stored in the pager database. Refer to Appendix H for a definition of the COMP1 protocol.

Independent of operating modes, you can configure the serial port baud and parity, and you can configure whether hardware or software flow control is used.

DIP Switch Settings


1 2 3 4 5 6 7 8
Flow Ctrl*
1 = H/W
0 = S/W
Baud (Serial Interface)
11 = 9600
10 = 2400
01 = 1200
00 = 300
Parity (Serial Interface)
11 = None (N81)
10 = None (N81)
01 = Even (E71)
00 = Odd
Protocol
111 = TAP Verbose
110 = TAP Non-Verbose
101 = COMP1 Verbose
100 = COMP1 Non-Verbose
011 = WaveWare
010 = WaveWare
001 = COMP2 Verbose
000 = COMP2 Non-Verbose
* NOTE: Hardware and software flow control signals are operational only when the "Flow Control Before Serial Response" option is enabled in the Advanced Encoder Setup section of the encoder setup software.
ON
1 2 3 4 5 6 7 8
1 = ON
TAP Protocol
at 9600 N 8 1
ALL DIP switches
are in the ON Position
WaveWare Protocol
at 9600 N 8 1:
DIP Switch 6 in the
OFF Position with
all others ON
NOTE: For Programming the WaveWare SPS-5 v7 Paging Encoder's Database,
the SPS-5 v7 works best at the setting of 9600 N 8 1 using TAP Protocol.

* NOTE: Hardware and software flow control signals are operational only when the "Flow Control Before Serial Response" option is enabled in the Advanced Encoder Setup section of the encoder setup software.

Appendix C – TAP Checksum Calculation

Following is sample Visual Basic™ code that creates a string to be sent to the paging system. A subset of the string has a checksum calculation performed on it, and then the checksum and a control character are appended to form the string to be sent to the paging system. Refer to the TAP specification at http://www.pcia.com, for more details on the checksum calculation.

```
'String that checksum is calculated on, of the form:
'<STX>ID<CR>Message<CR><ETX>
    TXString$ = Chr(2) & txtID.Text & Chr(13) & txtMessage.Text & Chr(13) & Chr(3)
'Calculate and append checksum
    j = 1
    Sum = 0
    Do Until j > Len(TXString$)
       B$ = Mid(TXString$, j, 1)
       D = Asc(B$)
       Sum = Sum + D
       j = j + 1
    Loop
'Create the three characters to be transmitted to represent this checksum.
    d3 = 48 + Sum - Int(Sum / 16) * 16
    Sum = Int(Sum / 16)
    d2 = 48 + Sum - Int(Sum / 16) * 16
    Sum = Int(Sum / 16)
    d1 = 48 + Sum - Int(Sum / 16) * 16
    Check1$ = Chr$(d1)
    Check2$ = Chr$(d2)
    Check3$ = Chr$(d3)
    CheckSum$ = Check1$ & Check2$ & Check3$
'Create complete string to be sent to paging system, of the form:
'<STX>ID<CR>Message<CR><ETX>Checksum<CR>
    TXString$ = TXString$ & CheckSum$ & Chr(13)
```

Appendix D – TAP Response Codes

Following is a table of response codes supported by the **WaveWare Paging System**. Please note that a <NAK> response typically means the message should be resent by the host, and an <RS> response typically means the message should be abandoned by the host.

Response Code	Definition
110 1.8	Paging system supports TAP Specification v1.8
211 Page(s) Sent Successfully	Paging message(s) successfully delivered. This message is accompanied by an <ACK>
510 Invalid character in pager ID	Pager ID field contains illegal characters. This message is accompanied by an <RS>
511 Invalid pager ID - not in database	Pager ID was legal and 1 to 4 characters in length, but didn't match database lookup. This message is accompanied by an <RS>
512 Temporarily cannot deliver. Queue full. Try later	Paging System input buffer is full. This message is accompanied by an <RS>
514 Checksum Error. Exp XXX; Got: YYY	Checksum didn't match message block. This message is accompanied by a <NAK>

Note: <ACK>, <NAK>, and <RS> are only representations of the lower order ASCII control characters output by the paging system. <ACK> represents Hex 06, <NAK> represents Hex 15, and <RS> represents Hex 1E.

Appendix E – Extended ID Processing

The WaveWare TAP interface and both COMP2 interfaces support ID field lengths from 1 to 10 digits. The ID field can be formatted as follows:

- Standard Method - ID field lengths from 1 to 4 digits will cause a pager database lookup. ID fields of this format must contain numeric digits only. The numeric ID value will be compared to the ID values stored in the **WaveWare Paging System**'s onboard pager database.
- Extended ID Method - ID field lengths from 5 to 10 digits will cause Extended ID processing. Extended ID processing assumes that the last 3 digits of the ID field define paging message encoding attributes, while the preceding digits define the pager capcode. Extended ID processing allows you to avoid the process of configuring a pager database in the **WaveWare Paging System**

Extended ID fields should be of the form:

CCCCCCCERF, where **C** represents the capcode, **E** represents Message Encoding Type, **R** represents RF data rate, and **F** represents Function Code.

The Extended ID field can be represented in either numeric or alphanumeric format. All Extended ID fields must be between 5 and 10 digits in length to cause the paging system to perform Extended ID processing. Incorrect formatting of extended ID fields causes a <NAK> response combined with an explanation message.

CCCCCCC is a 2 to 7 digit numeric value representing a pager capcode. Leading zeroes are optional except in the case of capcodes 8 and 9, which should be represented with at least one leading zero, e.g. 08 or 09.

E is the message encoding type, where "**0**" (zero), "**n**", or "**N**" represent "numeric encoding", and "**1**", "**a**", or "**A**" represent "alphanumeric encoding". The numeric values for **E** are provided to support numeric-only ID fields in paging control software.

R is the RF data rate, where "**5**" represents 512 bps, "**1**" represents 1200 bps, and "**2**" represents 2400 bps.

F defines the function code to be delivered, where "**1**" is function code 1, "**2**" is function code 2, "**3**" is function code 3, and "**4**" is function code 4. A function code of "**0**" is also valid. A function code of "**0**" causes the default function code for a particular Message Encoding Type ("**E**") to be substituted. The default value for **F** is "**4**" when the **E** value is "alphanumeric encoding", and "**1**" when the **E** value is "numeric encoding".

Following are valid example Extended ID fields causing Extended ID processing:

08A20 – Causes delivery of a standard (function code 4) alphanumeric message to capcode 0000008 at 2400 bps

08A24 – Same result as above

0008124 – Same result as above

0000008124 – Same result as above

11A53 – Causes delivery of an alphanumeric message with function code 3 to capcode 0000011 at 512 bps

0000011A53 – Same result as above

11N53 – Same result as above, but with numeric encoding

038N52 – Causes delivery of a numeric message with function code 2 to capcode 0000038 at 512 bps

Appendix F – Embedded Control Characters

When using WaveWare mode it is not necessary to make use of the <SUB> control character. Since WaveWare mode does not use the <CR> control character it is only necessary to hit carriage return on your keyboard to have it show up on the pager display.

To embed a control character in a TAP mode paging message however, it is necessary include a <SUB> control character followed by an offset version of the control character you want to embed. You offset the control character by adding 40 HEX to the control character, to make the character printable. Adding 40 HEX to Carriage Return gives you M. Adding 40 HEX to Line Feed gives you J. The character combination of <SUB>M causes a Carriage Return control character to be embedded in the encoded paging message, while <SUB>J causes a Line Feed control character to be embedded. The <SUB> character needs to be passed to the **WaveWare Paging System** as a HEX character.

In the WaveWare Paging Encoder Setup software, you can embed a Carriage Return by entering <CR> in the message body, and embed a Line Feed character by entering <LF> in the message body. The use of the <SUB> character will be done by the software.

In the Microsoft Visual Basic programming language, you can use the following code example to define the embedded control character string to be delivered through the serial port to the paging system. In this example, we are embedding only the Carriage Return control character:

```
DIM CarriageReturnString As String,
DIM MessageLine1 As String
DIM MessageLine2 As String
DIM TXString As String
CarriageReturnString = Chr(26) & "M"
LineFeedString = Chr(26) & "J"
MessageLine1 = "Line 1 of test message"
MessageLine2 = "Line 2 of test message"
TXString = MessageLine1 & CarriageReturnString & MessageLine2
form1.MSComm1.Output = TXString
```

Appendix G – WaveWare Interface Specifications

This appendix is included for those who want to develop their own paging control software or add an interface for the **WaveWare Paging System** to their existing software applications. You can choose to use the WaveWare paging protocol defined in this appendix, the TAP paging protocol, defined in Appendix A – TAP Interface Specifications, COMP1, or COMP2, defined elsewhere in this manual.

A simple definition of the difference between the WaveWare and TAP protocols is that the WaveWare protocol is a dedicated connection that doesn't require a login process and it assumes that the Host Device maintains a database of all paging parameters associated with a pager, including Capcode, Encoding Method, and RF Data Rate. The TAP protocol requires a connect and disconnect process and assumes that the Host Device only needs to maintain a database of pager reference numbers called PINs, and that the paging system maintains a database of all paging parameters associated with each PIN. The WaveWare interface supports paging messages up to 512 characters in length while the TAP interface supports paging messages up to 256 characters in length, group paging, contact monitoring, and timed messaging. Each protocol has its advantages and disadvantages, but both accomplish the process of causing POCSAG encoded paging messages to be delivered to local area pagers.

To configure your **WaveWare Paging System** to use the WaveWare paging protocol, you may be required to configure the DIP switch bank in the paging transmitter. Please refer to Appendix B – DIP Switch Settings, for details on configuring communication protocols. As a quick reference, the DIP switch setting for the WaveWare interface is DIP switch 6 in the off position and all other DIP switches on, which tells the system to operate in WaveWare interface mode, with communication parameters of 9600N81.

Your **WaveWare Paging System** typically communicates with a Host Device via RS-232 at 9600 Baud, 8 data bits and 1 stop bit. The eighth data bit is ignored (no parity). You can configure the paging system for other serial communication parameters. Please refer to Appendix C – DIP Switch Settings, for details on serial communication parameters.

The paging system maintains an input buffer which can receive commands from the Host Device while a page is being transmitted. The input buffer should be able to contain approximately ten paging messages before getting full. When a command is received from the Host Device, the paging system responds with a message that includes error messages if the command was not understood or not properly transmitted. The normal response will echo the paging request command along with a status message.

The paging system can use hardware handshaking (CTS) to control the flow of paging message commands from the Host Device. Alternatively, the paging control software could use the response messages as a means of handshaking between the paging transmitter and the paging control software.

The paging transmitter encodes paging messages into POCSAG paging format and transmits the encoded paging message. If the Carrier Detect function is enabled, transmissions will be delayed while interfering signals are detected.

To use group paging in WaveWare mode, simply use the WaveWare Encoder Setup software to setup a group list in TAP mode. The software can also be used to setup contact monitoring, for more information on contact monitoring, read Appendix K – Contact Monitoring Function. The Host Monitoring function, which affects group paging, of the WaveWare Paging Encoder System can be reset in WaveWare mode only if the PPHRESET option is active. For more information on Host Monitoring, its functions and how to reset it, refer to Appendix J – Timed Messaging.

The commands available for serial port controlled paging using the WaveWare Paging Protocol include:

- System Identification
- Paging Message
- Setup
- Status

PAGING MESSAGE COMMAND

The Paging Message command is formatted as follows:

Example 1:

<SOH>TBCC...C<STX>XXXX...XXX<ETX><EOT>

Example 2:

<SOH>T,B,CC...C,<STX>XXXX...XXX<ETX><EOT><CR><LF>

Note: The commas, the <CR> character, and the <LF> character are optional in the Paging Message command. They are used for appearance purposes to separate subparts of the command string and for formatting the echoed output while troubleshooting the system.

<SOH> (Hex code 01) is used to mark the start of a message. This character resets the paging system and can be used to abort an incomplete paging command at any point prior to transmission.

T Alphanumeric character representing the type of paging message to be transmitted

A = Alphanumeric

N = Numeric

1 = One Beep (tone/vibe only pagers)

2 = Two Beeps (all pager types)

3 = Three Beeps (all pager types)

4 = Four Beeps (tone/vibe only pagers)

B Numeric character representing the data rate, in bits per second, at which the paging message is to be transmitted

5 = 512 bps

1 = 1200 bps

2 = 2400 bps

Note: This numeric character may have one or no leading commas separating it from the paging message type.

C...C One to seven decimal numeric digits representing the capcode of the paging receiver to which the message will be transmitted. Capcodes are seven digit strings. Capcodes

that begin with leading zeroes do not require the leading zeroes to be included in this numeric string, if you use comma delimiters. If comma delimiters are not used, you must include leading zeroes.

Note: This numeric string may have one or no leading commas separating it from the data rate.

<STX> (Hex code 02) is used to mark the beginning of a string of message characters to be transmitted. For paging message types of 1 to 4 Beeps (defined by the 'T' character above), this character and all following characters are ignored by the paging transmitter, until another <SOH> is encountered. This character may have one or no leading commas separating it from the capcode.

X...X A string of 0 to 256 alphanumeric message characters to be transmitted. For paging message types of 1 to 4 Beeps, this character and all following characters are ignored by the paging system, until another <SOH> is encountered.

<ETX> (Hex code 03) is used to mark the end of a string of message characters to be transmitted. For paging message types of 1 to 4 Beeps, this character and all following characters are ignored by the paging system, until another <SOH> is encountered.

<EOT> (Hex code 04) is used to mark the end of a Transmit Paging Message command string. All following characters are ignored by the paging system until a <SOH> character is encountered.

<CR><LF> (CR is Hex code 0D, LF is Hex code 0A) These characters are ignored by the paging system unless contained within a message string and are used only for formatting output on a PC. The <CR> and <LF> characters are optional.

Example 1:

<SOH>A,5,46180,<STX>This is a test<ETX><EOT><CR><LF>

will send the message "**This is a test**" at 512 bps to an alphanumeric pager with capcode 0046180.

Note: The POCSAG alphanumeric character set is the entire ASCII 7 bit character set.

Example 2:

<SOH>N,5,0765155,<STX>412-3433<ETX><EOT><CR><LF>

will send the message "**412-3433**" at 512 bps to a numeric pager with capcode 0765155.

Note: The POCSAG numeric character set allows Hyphen (-), space, left bracket ([), and right bracket (]) characters in addition to the normal numeric character set.

Example 3:

<SOH>N1765155<STX>412-3433<ETX><EOT>

will send the message "**412-3433**" at 1200 bps to a numeric pager with capcode 0765155. Note the lack of commas and the implied leading zeroes on the capcode.

Example 4:

<SOH>3,1,145678<EOT>

will send a three beep tone/vibe only message at 1200 bps to a tone/vibe only, a numeric, or an alphanumeric pager with capcode 0145678 and multiple tone/vibe cadence capability. Certain paging receiver models may not be designed to respond to multiple tone/vibe cadence messages.

Example 5:

<SOH>2,1,145678<STX>412-3433<ETX><EOT>

will send a two beep tone/vibe only message at 1200 bps to a paging receiver with capcode 0145678. Note that the portion of the string after the capcode is ignored by the paging system because the paging message type was a paging message type of one to four beeps.

Example 6:

<SOH>450006123<EOT><CR><LF>

will send a four beep tone only message at 512 bps to a paging receiver with capcode 0006123.

RESPONSE TO ALL COMMANDS

The paging system will respond immediately to all commands, including Paging Message commands, Setup Commands, and Status Commands, by echoing the Paging Message command back to the PC, and appending the echoed command with a status message in one of the following formats:

<SOH><ACK>V..V,QQ,D,C,II<EOT>

The ACK response is sent by the paging system to the PC immediately following a command if the command was understood by the paging system.

<SOH><NAK>EE<EOT>

The NAK response is sent by the paging system to the PC immediately following a command if the command was not understood by the paging system or if certain errors occur.

<SOH> (Hex code 01) is used to mark the start of a message.

<ACK> (Hex code 06) is used to indicate acknowledgement of valid reception of a command from the PC.

V..V Alphanumeric string that indicates the version number of the firmware in the paging system. The version number is followed by a comma character.

QQ A one to two numeric character string that indicates the quantity of paging messages that have been received by the paging system and not yet transmitted (Input Queue).

The QQ value is followed by a comma character. This parameter should be monitored if you intend to use software handshaking between your paging control software and the paging transmitter. The paging transmitter Input Queue overflows if the QQ value tries to exceed 14. As an example, with software handshaking, your software should stop sending data at a QQ value of 12 and resume sending data when the QQ value reaches 10 or less. You can query the size of the Input Queue by submitting a Status Command, described on the following pages.

D Numeric character that indicates whether the carrier detect circuit in the paging system is currently detecting a carrier signal or not. Valid values are:

0 = Carrier Signal Not Detected
1 = Carrier Signal Detected

Note: The carrier detect signal status is passed to the PC whether or not the paging system has been programmed to avoid transmitting when a carrier signal has been detected (see Programming Command below).

C A single numeric value used to indicate the On/Off state of the Carrier Detect mode. The numeric character is followed by a comma.

Valid values (C) are:
0 = Off
1 = On

II A two hexadecimal digit value that is reserved for future use.

<EOT> (Hex code 04) is used to mark the end of a message

<NAK> (Hex code 15) is used to indicate non-acknowledgment of a command from the PC.

<EE> Two numeric characters that indicate the particular error that caused no acknowledgment of a command from the PC. The possible error values are:

01 = Invalid Message Type. Indicates a message type other than A, N, 1-4 was transmitted.

02 = Invalid Data Rate. Indicates a data rate other than 5, 1, or 2 was transmitted.

03 = Invalid Capcode. Indicates an invalid capcode was transmitted. Invalid capcodes are: 0-7, 2007664-2007671, 2045056-2045063, 2097144+.

04 = Input Buffer Overflow. Indicates the serial data input buffer in the paging system has overflowed. This condition would likely be caused by the host system not recognizing the CTS signal.

05 = Paging Buffer Overflow. Indicates the encoded paging message output buffer in the paging system has overflowed. This condition would likely be caused by excessive carrier signal detection while the Carrier Detect mode was enabled.

06 = Invalid Status/Setup Command. Indicates that the command was recognized as a Status or Setup command but the entire command string was not fully interpreted by the paging system.

07 = EEPROM Write Error. Indicates an internal system error in the paging system with regard to the proper storage of configuration information. This condition would likely indicate that paging system repair is required.

08 = Invalid Command Format. Indicates that the command was not fully recognized as a valid paging system command.

Example 1:

<SOH>A,5,46180,<STX>This is a test<ETX><EOT><SOH><ACK>V3.00,00,0,1,1A<EOT>
echoes the paging message command and acknowledges proper receipt of a command by appending the ACK, indicating paging system firmware version is 3.00, no paging messages in queue, no carrier signal is being detected, and Carrier Detect mode is set to ON. The last field does not currently provide useful information.

Example 2:

<SOH>4,5,0000006<EOT><SOH><NAK>03<EOT><CR><LF>
echoes the paging message command and indicates an error in receiving a command due to an invalid paging receiver capcode in a Paging Message command. Includes a <CR> and <LF> at the end of the response string if they were included in the paging message command.

SETUP COMMAND

You may program the **WaveWare Paging System** to monitor for interference using the Carrier Detect mode. If the Carrier Detect mode is turned on, the paging system will hold paging messages in queue until an offending carrier signal is no longer detected at the transmission frequency of the paging system. The settings programmed by the Setup command will be remembered by the paging system even if power is removed from the paging system. The Setup command is formatted as follows:

<SOH>S,X,V<EOT>

Where the S indicates Setup Mode, X is the command type, and V is the value. The comma delimiters are optional.

X A single numeric value used to indicate the command type. The numeric character is followed by a comma.

Valid values (X) are:

1 = Carrier Detect Mode

V A single numeric value used to indicate the value of the command setting to be saved. The numeric character is followed by an EOT character.

Valid values (V) are:

0 = Off

1 = On

Example 1:

<SOH>S,1,0<EOT> will set the Carrier Detect function to the Off status.

Example 2:

<SOH>S11<EOT> will set the Carrier Detect function to the On status.

STATUS COMMAND

You may request the paging transmitter to respond with its current programmed settings using the Status command. The Status command is formatted as follows:

<SOH>S?<EOT>

Where the S? requests the paging system to respond with the status of its current programmed settings. The Status Command can be used in supervisory controlled applications to ensure the transmitter is still functioning, without causing unwanted paging transmissions.

Appendix H – COMP1 Interface Specifications

This appendix is included for those who want to attach the **WaveWare Paging System** to existing systems that output raw data or simple data strings that are normally used in printing status logs on serial printers. The COMP1 protocol is designed to emulate one of the operational modes of the Motorola People Finder™ paging system.

A simple definition of the COMP1 protocol is that the COMP1 protocol allows raw ASCII data to be sent to all pagers in the Group one list of the **WaveWare Paging System**'s group database. The group lists must be defined in TAP mode using the WaveWare Paging Encoder Setup. The COMP1 interface supports paging messages up to 255 characters in length, contact monitoring, and timed messaging.

To configure your **WaveWare Paging System** to use the COMP1 paging protocol, you may be required to configure the DIP switch bank in the paging encoder. Please refer to Appendix B – DIP Switch Settings, for details on configuring communication protocols. As a quick reference, the DIP switch setting for the COMP1 interface is switch 7 in the OFF position and all other switches in the ON position. This tells the system to operate in COMP1 interface mode, with communication parameters of 9600N81, with hardware flow control.

Your **WaveWare Paging System** typically communicates with a PC or other host device via RS-232 at 9600 Baud, 8 data bits and 1 stop bit. The eighth data bit is ignored (no parity). You can configure the paging system for other serial communication parameters. Please refer to Appendix B – DIP Switch Settings, for details on serial communication parameters.

The paging system maintains an input buffer, which can receive commands from the PC while paging messages are being transmitted. The paging encoder encodes paging messages into POCSAG paging format and transmits the encoded paging message through the internal radio transmitter. If the Carrier Detect function is enabled, transmissions will be delayed while interfering signals are detected.

Control characters recognized by the paging encoder in COMP1 protocol mode include:

CARRIAGE RETURN	<CR>	$0D
LINEFEED	<LF>	$0A

Control characters generated by the **WaveWare Paging System** in COMP1 protocol mode when software flow control mode is active include:

XON	<XON>	$13
XOFF	<XOFF>	$11

In COMP1 interface protocol, the **WaveWare Paging System** does not provide feedback response signals on the serial port, other than flow control signals. COMP1 is a one way (simplex) protocol.

The COMP1 operation is as follows: When incoming data is detected on the serial port, one of three things will happen: 1) A carriage return character is detected in the datastream, 2) a time period of approximately 10 seconds elapses after receipt of the last character on the serial port, or 3) 256 characters or more accumulate in the serial port input buffer. If any of these three events occur, the paging system will strip any carriage return and linefeed characters and transmit the remainder of the datastream to all pagers defined in the encoder's pager database.

If the serial port input buffer becomes filled with greater than 1000 characters, the paging system will output either a hardware or software flow control response, depending upon how DIP switch 1 is configured. Once the serial port input buffer drops below 450 characters, the paging system will use flow control signals to indicate that it is no longer busy and that additional data can be delivered to the serial port.

NOTE: When using COMP1 mode, please note that all data is transmitted to the pagers listed in group one of the **WaveWare Paging System** pager database. When setting up for COMP1 operation, you should limit the pager quantity in the pager database to no more than a few pagers, in order to avoid excessive paging transmissions.

Appendix I – COMP2 Interface Specifications

This appendix is included for those who want to attach the **WaveWare Paging System** to existing systems that output simplified paging system control commands. The COMP2 protocol is designed to emulate one of the operational modes of the Motorola People Finder™ paging system. There are two possible modes for COMP2, the Verbose and Non-Verbose modes. The Verbose mode has been designed to have human readable responses to message inputs and certain errors. The Non-Verbose mode has no readable responses in it.

A simple definition of the COMP2 protocol is that the COMP2 protocol allows a message formatted as PagerID<CR>Message<CR> to cause the Message to be delivered to the associated PagerID defined in the **WaveWare Paging System**'s pager database. The COMP2 interface supports paging messages up to 253 characters in length, group paging, contact monitoring, and timed messaging. The total length of the control string, including <CR> and <LF> characters, cannot exceed 256 characters. The PagerID field can be from 1 to 10 characters in length. PagerID field lengths from 5 to 10 digits are assumed to be Extended Pager IDs (See Appendix E – Extended Pager ID Processing). Carriage Return is the normal field delimiter in COMP2 protocol, but the tilde (~) character is also supported as a delimiter.

To configure your **WaveWare Paging System** to use the COMP2 paging protocol, you may be required to configure the DIP switch bank in the paging encoder. Please refer to Appendix B – DIP Switch Settings, for details on configuring communication protocols. As a quick reference, the DIP switch setting for the COMP2 Verbose interface is switches 6 and 7 in the OFF position and all other switches in the ON position. COMP2 Non-Verbose mode is activated by simply turning off switch 8 in addition to 6 and 7. These settings tell the system to operate in COMP2 interface mode, with communication parameters of 9600N81, with hardware flow control.

Your **WaveWare Paging System** typically communicates with a PC or other host device via RS-232 at 9600 Baud, 8 data bits and 1 stop bit. The eighth data bit is ignored (no parity). You can configure the paging system for other serial communication parameters. Please refer to Appendix B – DIP Switch Settings, for details on serial communication parameters.

The paging system maintains an input buffer, which can receive commands from the PC while paging messages are being transmitted. The paging encoder encodes paging messages into POCSAG paging format and transmits the encoded paging message through the internal radio transmitter. If the Carrier Detect function is enabled, transmissions will be delayed while interfering signals are detected.

Control characters recognized by the paging encoder in COMP2 protocol mode include:

CARRIAGE RETURN	<CR>	$0D
LINEFEED	<LF>	$0A
TILDE	~	$7E
DELETE	<DEL>	$7F or $FF

Control characters generated by the **WaveWare Paging System** in COMP2 protocol mode when software flow control mode is active include:

CARRIAGE RETURN	<CR>	$0D
XON	<XON>	$13
XOFF	<XOFF>	$11
ABANDON TRANSACTION	<RS>	$1E

The **WaveWare Paging System** in COMP2 mode is controlled using control strings formatted as follows:

Single Message Example using Carriage Return as delimiter:

PagerID<CR>Message<CR>

Single Message Example using Tilde as delimiter:

PagerID~Message~

Tone/Vibe Only Example:

PagerID<CR><CR>

Multiple Message Example:

PagerID1<CR>Message1<CR>PagerID2<CR>Message2<CR>

Forced Resynchronization Example:

<DEL><DEL><DEL>PagerID<CR>Message<CR>

Multiple Messages using Forced Resynchronization Example:

<DEL><DEL><DEL>PagerID<CR>Message
1<CR><DEL><DEL><DEL>PagerID<CR>Message 2<CR>

When incoming data is detected on the serial port, one of three things will happen: 1) The data in the serial port input buffer contains properly formatted COMP2 command strings, 2) a time period of approximately 10 seconds elapses after receipt of the last character on the serial port, or 3) 256 characters or more accumulate in the serial port input buffer. The serial port data is analyzed character by character to see if a properly formatted command string exists. If the serial port data contains one or more properly formatted COMP2 command strings, then the paging message(s) will be transmitted to the specified pager ID(s) as long as those pager ID(s) exist in the **WaveWare Paging System**'s pager database. If a pager ID doesn't exist in the pager database, an error message will be output in Verbose mode by the paging system as follows:

Invalid character in pager ID<CR><CR><RS><CR>

Any portions of the serial port input buffer that don't meet the COMP2 message formatting requirements are discarded. The original COMP2 protocol has an inherent weakness of using the <CR> character to delimit both the Pager ID field and the Message field. This approach allows the possibility of an extra or missing <CR> character to cause the host system and the paging system to get out of synch with each other, causing multiple paging messages to be rejected by the paging system. A more robust version of the COMP2 protocol uses three <DEL> characters as indicators of the beginning of a COMP2 command string. The use of three <DEL> characters at the beginning of each output message assures that out-of-synch conditions will not occur. The forced resynchronization method is optional. As additional synchronization insurance, the WaveWare COMP2 implementation has been designed to stay in synch even if one or more <CR> characters immediately precede a properly formatted COMP2 command string.

If the 10 second timeout occurs while waiting for all of the characters required for a properly formatted COMP2 message to arrive on the serial port, the data in the serial port input buffer will be discarded. If 256 or more characters arrive in the paging system's serial port input buffer, and the first 256 characters contain all of the elements of a properly formatted COMP2 command string except for the trailing <CR> character, then the <CR> will be assumed and only the first 256 characters of the input buffer will be processed as a valid COMP2 paging message.

If the serial port input buffer becomes filled with greater than 600 characters, the paging system will output either a hardware or software flow control response, depending upon how DIP switch 1 is configured. Once the serial port input buffer drops below 450 characters, the paging system will use flow control signals to indicate that it is no longer busy and that additional data can be delivered to the serial port.

Appendix J – Timed Messaging Function

The Timed Messaging Function is designed to allow the **WaveWare Paging System** to be used for purposes of automatically transmitting predefined messages upon timer related conditions. The Timed Messaging Function can be activated during the process of programming the pager database using the WaveWare Paging Encoder Setup software. The Timed Messaging Function is available in all modes of operation. The Timed Messaging Function operates as follows:

Concurrent with the encoder monitoring the serial port for normal paging messages, the Timed Messaging Function uses an internal 1.06 minute timer cycle to determine whether or not to transmit predefined messages. If the timer is not reset by the host system while the Timed Messaging Function is active, the paging system will transmit predefined messages as defined in the pager database configuration. The timer is reset under the following conditions if the Timed Messaging Function is active:

- Reception of a valid TAP protocol formatted control string on the serial port
- Reception of the ATI<CR> control string on the serial port

When programming the **WaveWare Paging System** pager database, each of the ten pager groups of up to 20 pagers per group in the pager database can be associated with the Timed Messaging Function and associated with one of up to 15 configurable predefined messages of up to 60 characters in length. If a pager group has the Timed Messaging Function active, all pagers in that pager group will receive a predefined message.

Some practical applications of the Timed Messaging Function are as follows:

- In mission critical environments, the Timed Messaging Function can be used to monitor the host system and notify someone's pager that the host system needs attention. To accomplish this, program the host control software to output a TAP message or the ATI<CR> command every minute. If the host gets disconnected from the paging system or the host stops functioning, the Host Monitoring Function will come into play.
- Use the Timed Messaging Function in a supervisory controlled paging system environment to allow other portions of the system to know that the paging system's encoder and transceiver are functioning properly, by monitoring for the predefined message being transmitted automatically by the paging system.

Appendix K – Contact Monitoring Function

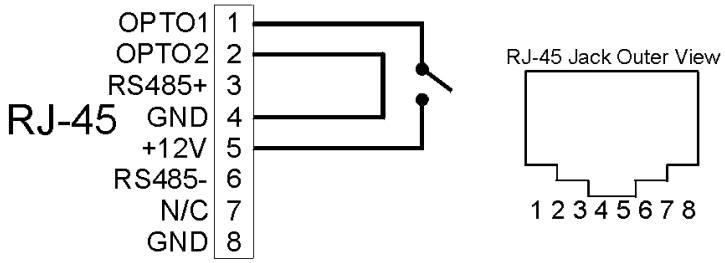
The Contact Monitoring Function is designed to allow the **WaveWare Paging System** to be used for purposes of automatically transmitting predefined messages upon contact closure and/or contact open conditions. The Contact Monitoring Function can be activated during the process of programming the pager database using the WaveWare Paging Encoder Setup software. The Contact Monitoring Function is available with the TAP, WaveWare, COMP1, and COMP2 modes of operation. The Contact Monitoring Function operates as follows:

Concurrent with the paging encoder monitoring the serial port for normal TAP messages, the Contact Monitoring Function monitors the signal going through the opto-isolated device attached to the RJ-45 8 pin connector. A contact closure event occurs when the opto-isolated device has 5V to 24V with a DC only current applied to it. A contact open event occurs when the opto-isolated device has a voltage less than 0.5V going across it.

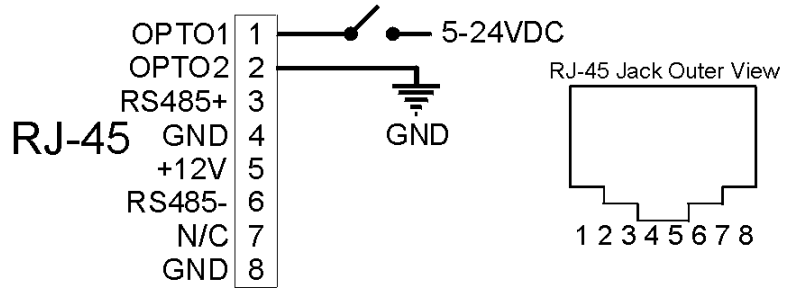
When programming the **WaveWare Paging System** pager database, each of the ten pager groups of up to 20 pagers per group in the pager database can be associated with the Contact Monitoring Function by using the Encoder Setup Software. If a pager group has the Contact Monitoring Function active, all pagers in that pager group will receive a predefined message.

Some practical applications of the Contact Monitoring Function include using a mechanical switch or other form of contact closure or contact opening to cause paging to occur. To accomplish this, connect to the RJ-45 8 pin jack per the pin-out information in Appendix L – Connectors and Indicators. Upon closure or opening, the paging encoder will output canned messages as required. Following are two example wiring diagrams.

Contact Monitoring Wiring Example
on WaveWare SPS-5v7 Paging System
Using Encoder as Voltage Source



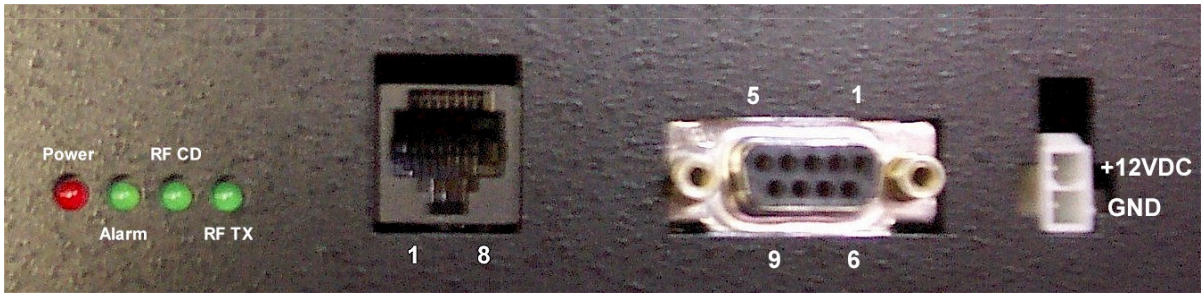
Contact Monitoring Wiring Example
on WaveWare SPS-5v7 Paging System
Using External Voltage Source



Appendix L – Connectors and Indicators

The SPS-5v7 paging system connectors include the following:

- Power (12VDC, 2 pin positive lock Molex)
- Serial Data (DB-9 female)
- Alarm Monitoring (RJ-45 jack, 8 pin). Pins 1 and 2 are the Opto-isolated contact monitoring input pins.



The SPS-5v7 paging system LED indicators include the following:

- Power (red LED)
- Alarm
- Carrier Detect
- RF TX

The pinout of the RJ-45 connector is:

1 Opto input #1
2 Opto input #2
3 RS-485- (not used in this model)
4 GND
5 +12V, current limited (available as voltage source for alarm input circuit)
6 RS-485+ (not used in this model
7 No connection
8 GND

The pinout of the DB-9F connector is:

1 CD (not used)
2 RD (data output by paging system, typically required)
3 TD (data received by paging system, required)
4 DTR (not used)
5 GND (required)
6 DSR (signal output by paging system, requirement depends on host system)
7 RTS (signal input to paging system, required only if hardware flow control mode is active)
8 CTS (signal output by paging system, required only if hardware flow control mode is active)
9 RI (not used)